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THE DESERT LICHENS OF RENO, NEVADA

ALBERT W. C. T. HERRE

Reno lies at the eastern foot of the Sierra Nevada Mountains, some 15 miles from the Nevada-California boundary line, at an altitude of 4500 feet. It is built on a level tract known as the Truckee Meadows, through which flows the Truckee River. Mountains hem in this grassy valley on every side. Peavine Peak, lying northwest of the city, rises from Reno itself to a height of 8270 feet, while a little farther away and off to the southwest stands Mount Rose, with an altitude of 10,800 feet. To the north and east stretches a rolling plateau, a part of the Great Interior Basin, ridged by numerous parallel mountain ranges between which are a few streams during the rainy season and many sinks or drainage basins without outlet.

The average precipitation at Reno, as determined by observations at the University of Nevada over a period of 17 years, is 8.21 inches. A large part of this falls as snow during the winter months, or as early spring rains. The summer is hot and dry, very light showers occurring rarely. Late in the autumn light rains fall occasionally. During the entire year the diurnal changes of temperature, as in all desert regions, are very great. In winter the days are generally clear and sunny, the temperature dropping below freezing, or in some years even sometimes as low as $-15°$ F. at night. Throughout the year strong drying winds from the west or north are very frequent, though these same west winds also bring what little rain there is. But usually they have lost their moisture in crossing the Sierras and are drying winds in Nevada. The spring is late and backward, killing frosts often occurring the last of May, and frost may occur in midsummer.

On the desert plateau proper there are no trees, except on the mountains above 6000 feet, the chief woody plants being sage brush, an *Ephedra* (Indian tea), *Grayia spinosa* (bud sage), *Emplectocladus Andersoni* (wild peach), *Purshia Kunzia* (bitter brush), and perhaps a few other insignificant shrubs. On the mountain slopes and in the cañons above 6000 feet are found scattering clumps of *Pinus ponderosa* and *Juniperus occidentalis utahensis*, the latter sometimes forming real groves; while species of *Cercocarpus*, *Amelanchier*, and *Ceanothus* form shrubby patches 1–2 feet high, or become scraggly scattered bushes, or even trees 6–10 feet in height.

The region studied since October 1909 extends from the university campus in the city of Reno north and west a distance of 12 miles, and north and northeast about 6 miles. This district rises from 4500 feet to an altitude of over 8000 feet, the exposed rocks being mainly andesite and rhyolite.

At 5000 feet and upward lichens are, in general, exceedingly abundant on all outcropping ledges, stone pinnacles, or cliffs, as well as on the loose rocks which lie scattered about or piled in excessive quantities everywhere; but the few trees and the shrubs carry very few or no lichens. On the slopes of both Peavine and Mt. Rose I have vainly scrutinized the trunks and limbs of *Pinus ponderosa* for lichens. The trees were actually as bare as a new and freshly painted hitching post. The same condition is true of *Juniperus* out on the desert, 6 miles northeast of Reno, but 12 or 15 miles away, where there are belts of uncut juniper, *Letharia vulpina* is abundant upon it.

Before entering into a further discussion of the lichen flora of this region and the conditions which control it, let us examine the following list, which I am satisfied includes almost every species occurring below 8000 feet in this district. On Mount Rose a number of other forms appear near the summit, but the alpine lichens of that peak will be considered in a subsequent paper, as they bear no relation to the desert flora below.

1. VERRUCARIA FUSCELLA (Ach.) Turn.

2. VERRUCARIA STANFORDI Herre.—The discovery of this species here, described from the Santa Cruz Peninsula, California, greatly extends its range and is an interesting find. In addition to the type locality, I have this species from the Inner Coast Range, the Sierra Nevada Mountains along the California-Nevada boundary line above Verdi, and from the desert near Reno.

3. DERMATOCARPON MINIATUM (L.) Mann.

4. DERMATOCARPON MINIATUM COMPLICATUM (Sw.).

5. ENDOCARPON PUSILLUM Hedw.

6. **Endocarpon tortuosum** Herre, n. sp.—Thallus of small or irregular foliose squamules, tortuous and nodulose, often forming a rough, thick, and very irregular indeterminate crust; sometimes the squamules are densely compacted to form a thick, almost uniform torulose crust, while the squamules are stipitate, erect, and 7 mm. or more in height. When the squamules are scattered, their lobes are much dissected, and more or less complicate, recalling *E. pulvinatum.*

Color dull brown, verging from ashy brown to a dark, almost purplish brown; more or less greenish when wet; KOH−; $CaCl_2O_2$−.

Apothecia minute, immersed, the ostiolum sometimes visible with a strong lens; perithecium nearly colorless or very pale brownish; asci sub-cylindrical to saccate and top-shaped, $\frac{22.5-36}{85-135.5}\mu$, their contents copper red with I; paraphyses short, confluent, blue with I; spores 2, the upper one the larger, muriform-multilocular, the locules 4 across the spore, 10 or 12 in number the long way, at first colorless and mostly pale yellowish brown, but finally dark brown, $\frac{18-27}{45-61}\mu$; hymenial gonidia elliptical, measuring $\frac{2.75-3.3}{5.6-6.7}\mu$.

The plant is abundant 2 miles north of Reno, on shaded and relatively damp rock walls with a north or northeast exposure, at an altitude of 5000 feet. It is also frequent on cliffs in a cañon above Marmol, near the state boundary line, at an altitude of 6000 feet.

7. MICROTHELIA METZLERI Lahm.

8. LECIDEA ATROBRUNNEA (Ram.) Schaerer.—I have included under this name a large series of specimens which may represent two or three species. Some of the specimens bear a very close resemblance to *Lecidea fumosa* (Hoffm.) Ach., but do not agree in the apothecial structure. Other material is probably a new

species, but I place it here for lack of further material for comparison, and because as yet the abundant apothecia have not yielded me spores.

9. LECIDEA TESSELATA Floerke.

10. LECIDEA AURICULATA DIDUCENS Th. Fr.

11. LECIDEA SCOTOPHOLIS (Tuck.) Herre.—A doubt is cast upon this determination because of the small spores. A specimen from California, determined by TUCKERMAN, gives spores $\frac{3-5}{8-11}\ \mu$, while the Reno specimens have spores measuring but $\frac{3\cdot 5-4}{5\cdot 9-7\cdot 5}\ \mu$.

12. **Lecidea truckeei** Herre, n. sp.—Thallus indeterminate, apparently of medium-sized, rigid, leafy, thickish scales which are densely crowded, ascendant or imbricate, with entire or crenate margin. On removing a single plant it is seen to be peltate, prolonged downward into a stout irregular stem, and with a broad top (4–10 mm. wide) of imbricate lobules, which form the scales of the thallus as seen from above; the lobules usually concave or undulate, less often revolute, their upper surface characteristically finely reticulate and wrinkled to form convex areolae; color dull chestnut brown or yellow brown; under side of the lobules black, the stems a dusky ashen; medulla bluish or purplish with I; thallus dusky olive with $KOH+CaCl_2O_2$.

Apothecia small, usually numerous, black; at first very small and flat, with a thin, rather entire and slightly lighter-colored margin; becoming convex as they get larger, and more or less excluding the margin; sometimes they are conglomerate or clustered and irregular; epithecium greenish black; hypothecium brown or brownish; paraphyses confluent or agglutinate, slender, threadlike; thecium greenish pale, turning blue with I; the ventricose fertile asci are rare; spores globose, 4.66 to 7 μ in diameter.

On rhyolite, 2 miles north of Reno, at an altitude of 5000 feet, forming conspicuous patches several inches broad. Though bearing a superficial resemblance to an unusually luxuriant form of *Lecidea atro-brunnea* or some forms of *Lecidea globifera*, it is markedly different in both thallus and spores.

13. BACIDIA TRISEPTA (Naeg.) A. Zahlbr. (?) or BACIDIA LECIDIOIDES (Anzi) (?).—Determination uncertain for lack of properly

determined material for comparison. Spores in my specimens measure $\frac{4.5\text{–}5.6}{11.3\text{–}14.8}\ \mu$.

14. Rhizocarpon montagnei (Flot.) Koerber.

15. Biatorella revertens (Tuck.) Herre.

16. Acarospora rufescens (Sm.) Th. Fr.

17. Acarospora cervina (Pers.) Koerber.

18. Acarospora squamulosa (Schrad.) Th. Fr.—Spores of Reno material are $\frac{2.2\text{–}2.33}{4\text{–}5}\ \mu$. This is too small for *squamulosa*, but I cannot place our plant elsewhere.

19. Acarospora thamnina (Tuck.) Herre.—This is a peltate plant which I place here with doubt, having no material for comparison, but it agrees fairly well with the description.

20. Acarospora peltastica A. Zahlbr.—Occurring in small patches amid other lichens, and rather common on the rocky débris of the desert. Hitherto known only from the deserts of southeastern California.

21. Acarospora bella (Nyl.) Herre.

22. Acarospora chlorophana (Wahlb.) Mass.

23. Gyrophora reticulata (Schaer.) Th. Fr.

24. Gyrophora hyperborea (Hoffm.) Ach.

25. Gyrophora phaea (Tuck.) Herre.

26. Gyrophora erosa (Web.) Ach.—Usually dwarfed and non-typical.

27. Thyrea pulvinata (Schaer.) Mass.—In small holes or crevices on the south and southeast face of a rhyolite cliff.

28. Peccania arizonica (Tuck.) Herre. *Omphalaria arizonica* Tuck. *in litt.* (1884 ?).—Thallus indeterminate, dull, black, minutely fruticulose, forming sub-crustaceous pulvinate nodules, which to the naked eye appear to be composed of almost microscopic uniform granules; branches numerous, irregular, more or less knobbed, their tips often enlarged and broken up into several blunt points. Apothecia not known to me. "Spores 8, sub-globose, 0.75 μ."

A few scanty specimens were found growing on the minute quantities of earth which collects in small shallow holes on the south a face of rhyolite cliff 2 miles north of Reno.

I have a specimen collected by C. G. Pringle in the Santa Rita Mountains, Arizona, in 1884, and another collected by Dr. W. G. Farlow at El Paso, Texas, and both named by Tuckerman *in litt.* My material from Reno agrees with both of these specimens.

All three are sterile, but on the sheet to which the one from Arizona is fastened is written the spore measurements quoted by me above, presumably copied from Tuckerman's findings of other and fertile material.

29. Heppia guepini (Delis.) Nyl.

30. Lecanora gibbosa (Ach.) Nyl.—Part of the specimens are not at all typical and probably represent a new variety.

31. Lecanora calcarea (L.) Sommerf.

32. Lecanora olivacea (Bagl. & Car.) Steiner (?).—The spores of my material measure but $\frac{4.6}{8.1\text{–}9.3}\,\mu$, while in European material they measure $\frac{5\text{–}6}{10\text{–}14}\,\mu$; in other respects the plant seems to agree.

33. Lecanora saxicola (Poll.) Ach.—Our Nevada material is excessively variable and some forms are brought under this species with great difficulty. A brown, white-pruinose form is very common and may represent Tuckerman's var. *versicolor*, or it may be new.

34. Lecanora sp.—This lichen belongs to the *saxicola* group, but I am unable to determine it more closely. Intermediate between *L. saxicola* and *L. thamnoplaca*, but quite distinct from either.

35. Lecanora thamnoplaca Tuck.—Very abundant on loose rocks and on cliffs.

36. Lecanora melanophthalma (DC.) Jatta.

37. Lecanora rubina (Vill.) Ach.

38. Lecanora rubina heteromorpha Ach.

39. Candelariella cerinella (Flk.) A. Zahlbr.

40. Parmelia glabra Schaerer.

41. Parmelia exasperata (Ach.) Nyl.

42. Parmelia conspersa (Ehrh.) Ach.

43. Parmelia (?).—Too fragmentary for determination. On cold, shaded, north slopes.

44. PARMELIA PUBESCENS (L.) Wainio.

45. LETHARIA VULPINA (L.) Wainio.

46. XANTHORIA POLYCARPUS (Ehrh.).

47. XANTHORIA LYCHNEUS LACINIOSA (Schaerer).—The specimens are sterile but well marked, and grow on the north slope of a rhyolite cliff.

48. BLASTENIA FERRUGINEA (Huds.) Arn.

49. CALOPLACA ELEGANS (Link.) Th. Fr.

50. CALOPLACA ELEGANS TRACHYPHYLLUM Tuck.

51. CALOPLACA MURORUM (Hoffm.) Th. Fr.

52. CALOPLACA CINNABARINA (Ach.) A. Zahlbr.

53. BUELLIA ALBO-ATRA (Hoffm.) Th. Fr. and var. SAXICOLA Fries.

54. BUELLIA TRIPHRAGMIA Nyl.

55. RINODINA THYSANOTA Tuck.

56. RINODINA OREINA (Ach.) Mass.

57. PHYSCIA PULVERULENTA (Hoffm.) Nyl.—Specimens scanty and sterile.

58. PHYSCIA STELLARIS (L.) Nyl.

59. PHYSCIA TRIBACIA (Ach.) Tuck.

It is doubtful whether one should include *Letharia vulpina* as really belonging to the desert flora. In the western Sierras it is a very abundant and conspicuous lichen, but seems hardly able to withstand the drying winds of high velocity so characteristic of the western Nevada region. On Peavine Peak, at an altitude of 7000 feet, I found two small sterile specimens growing on the butt of a scraggly *Cercocarpus*. But as already stated, where there are groves of juniper it occurs in abundance, probably because there it is sheltered from the high winds which prevent its development in more exposed situations.

Parmelia pubescens occurs at about 7500 feet on Peavine Peak, and also very sparingly on a cold north wall, where it is well sheltered from the sun, at an altitude of 5000 feet. But it is really a plant of the high Sierras and cannot be reckoned as a real factor in the desert lichen flora.

This leaves us with 57 species and subspecies which we may safely include in the flora of the desert about Reno. Of this number only three dwell on wood; *Buellia triphragmia* occurs sparingly on the trunks and limbs of sage brush, while *Xanthoria polycarpus* is rather common on the same habitat, usually near the base of the gnarled and twisted trunk, where it is well sheltered by the densely branching shrub above. *Candelariella cerinella* is best developed and most abundant on rocks, but likewise occurs on clumps of dead moss in the shadow about the base of decumbent sage brush trunks, and to some extent on the trunks themselves; but it is, properly speaking, a rock lichen.

Comparing our 55 saxicolous lichens with the 25 obtained near the Carnegie Desert Laboratory at Tucson, Arizona, we find 22 genera represented at Reno, while only 11 were collected at Tucson. Apparently but 9 species are identical in the two localities.

Three genera are especially well represented about Reno: *Lecanora* with 9 forms, *Acarospora* with 7, and *Lecidea* with 5, these three comprising over 38 per cent of the species of rock lichens of the region. If we include the highly successful *Caloplaca elegans*, we have 4 genera of the 22 which probably cover three-fourths of the rock surface devoted to lichens; while the addition of *Rinodina* and *Gyrophora* would give us at least nine-tenths of the individuals found on the desert rocks. The remaining genera are not only poor in number of species but are also poorly represented by numbers of individuals. As we pass from desert to alpine conditions, we find that *Gyrophora* becomes the dominant genus, followed by *Acarospora*, *Caloplaca*, and *Lecidea*.

The rainfall at Tucson is 13.53 inches, or 42.87 per cent greater than at Reno. Yet no species of *Lecidea* were collected at Tucson, while at Reno the genus is well represented, relatively speaking. This shows that their absence at Tucson is not due to dryness, but to other causes. It will be noted that the chief representative of the genus at Reno is the alpine or subalpine *Lecidea atrobrunnea*. In like manner we may account for the prominence of the *Lecanora rubina* group at Reno and its entire absence at Tucson by the higher altitude and prevailing low temperature for a large part of the year at Reno, these species of *Lecanora* being characteristically subalpine or alpine plants.

The coloring characteristic of the rock ledges of the desert and cañon walls is often entirely due to lichens, and in a general way they form the only brilliant plant formations in a landscape notable for its subdued, pale, monotonous tones. Most conspicuous are *Acarospora chlorophana* and *Caloplaca elegans*, which form striking landmarks when covering great crags and rock walls. The next most conspicuous lichens are *Rinodina oreina* and *Lecanora rubina* and its allies, which often entirely cover immense bowlders and northerly sloping rock walls. In places *Gyrophora erosa* and *Gyrophora phaea* may cover the rocks to the exclusion of other forms, but their dull brown shades are not at all conspicuous. *Gyrophora reticulata* is sometimes the sole occupant of northwest exposures, when its black thallus becomes quite noticeable.

Candelariella cerinella and *Acarospora bella* are perhaps the only others which would attract the attention of the casual observer, nearly all the others having a dull or somber brown or dusky hue which blends in with the general rock color.

The species of *Dermatocarpon* occur in crevices of rock walls, especially on northeastern and southeastern slopes, where they receive the maximum of protection from drying winds. The few small specimens of *Physcia* occur in the same localities, where they are very little or not at all exposed to direct sunlight. The remaining lichens, except where previously noted, occur indifferently on all sides of bowlders or rock ledges, the sunniest and most arid of all possible situations, where one would hardly believe a plant could exist, being occupied by *Gyrophora phaea* and *Acarospora thamnina*. The largest and finest specimens of *Gyrophora reticulata*, as well as the best specimens of *Lecanora rubina*, are on northern or northwesterly exposures; this I attribute to the fact that these slopes are much colder, being exposed to the direct winds from the snow fields of the Sierras, and are also often covered for weeks with great snow drifts.

With the exception of *Lecanora rubina* and its allies, few of the well exposed rock lichens could fairly be called foliose. The short-lobed species of *Gyrophora* hug the rocks as closely as possible, so that they are truly crustose except when in some sheltered crevice or more than ordinarily favorable position. The quite inconspicuous and sterile thallus of *Parmelia exasperata* and *Parmelia glabra* is usually far more closely attached to the rocks than many of the species of *Lecidea* or *Acarospora.*

In FINK's study of the Tucson lichens, he speaks of the remarkable development of black lines or spots ôn the upper surface of every species having a light-colored thallus. I find practically nothing of the kind on the lighter-colored species at Reno, such as *Acarospora chlorophana*, *Acarospora thamnina*, *Lecanora gibbosa*, *Buellia albo-atra*, or *Physcia stellaris*, though all but the last named occur frequently where they are exposed to the full glare of a brilliant sun set in a cloudless sky for ten or twelve hours daily during most of the year. I do find some such dark spots on *Rinodina oreina*, but not any more, if as many, as occur on it in regions elsewhere with a rainfall of 20 inches. *Acarospora thamnina* and other sterile light-colored lichens are often blotched with dark spots simulating apothecia, but a section shows them to be parasitic fungi.

Certain species of *Acarospora* and *Lecidea* are noticeable for the thickness and comparative luxuriance of their thallus, and for their sterility, certain forms which I can identify with difficulty or not all at being persistently sterile though of a rank vegetative growth.

In his study of the Tucson desert lichen flora, FINK takes up the question of the amount of moisture desert rock lichens may obtain from the upward passage of water through the rocks. Geologists and botanists here in Nevada do not believe that lichens obtain any appreciable amount of water from the desert rocks upon which they grow by the upward passage of moisture through the rocks. All observation goes to substantiate FINK's statement "that lichens absorb at least a large proportion of the moisture needed directly from water vapor of the atmosphere and from water falling upon them." Incomplete experiments by me show that lichens not only retain a considerable amount of moisture within their thalli even in the driest times, but that they imbibe moisture from rain with very great rapidity and in great quantity, relatively speaking.

But that the desert lichens of this region do not depend upon water obtained by capillarity is readily understood when one examines the vast numbers of loose rocks lying upon air-dry soil, yet thickly covered with lichens. This fact is impressed still more strongly when one sees the luxuriant growth of certain lichens upon the loose slabs and fragments forming the talus about cliffs; often they are some feet above the soil or outcropping rock, and lie in such a position that the hot desert air blows all about them, under as well as over; yet the lichens seem to thrive as well on these fragments as on the cliff itself. In these cases it seems plain that the only source of water for the lichens thereon is from direct precipitation and from the atmosphere.

During the summer months it is highly probable that a careful study would show that the great diurnal drop in temperature which comes in all arid regions with the advent of darkness is likewise accompanied by a deposition of moisture upon, or at least an increase in water content of, the desert lichens.

When one considers that the temperature drops 30° to 35° F. every night during the summer months, it is apparent that without any increase in the actual amount of water present there is a great increase in the percentage of moisture, and it is believed by some of us that the lichens are able to take advantage of this relative increase and absorb enough moisture to maintain their vitality during the long, hot, dry season.

Though the winters here are characterized by a comparatively low temperature, they are yet open and sunny, so that during the daylight hours they are usually quite mild. This mildness and the fact that the winter is the season when most moisture is available, especially that from melting snows, cause the lichens to have their period of most active growth during the months from November to June. Except under unusually favorable conditions, it is not likely that the Nevada desert lichens are more than able barely to keep alive during the remainder of the year.

That desert conditions are, in the main, unfavorable to the growth of lichens as a whole is shown by the limited number of genera and species represented, while a considerable number of those found are able to maintain themselves only in the most favorable spots, such as under overhanging rocks on the north side of cliffs, or deep within crevices. But that some species are perfectly at home in the midst of the most adverse desert conditions of excessive light and dryness is shown by the fact that almost everywhere the rocks are just as thickly covered with lichens as in other regions of greater humidity and less sunshine. The desert does not lack in number of individuals, but in number of species of lichens able to adapt themselves to its conditions.

OAKLAND, CALIFORNIA